Report from the Silicon Review Committee

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Version 7

1 Introduction and Charge

The above review committee was assembled at the end of September, 1999 by DØ management (Montgomery, Tuts, and Weerts). The committee was charged with evaluating the silicon project organization, technical production status and plans, and resource availability and allocation, in whatever manner the committee felt would be most efficient. The committee was also asked to put forth whatever recommendations they felt would help the silicon project meet their current schedule, which shows completion of the detector in September, 2000.

After discussions and a tour of the SiDet facility with silicon project managers Ron Lipton and Bill Reay, the committee interviewed many of the physicists involved in the project, as well as some of the technicians. Discussions with physicists Bill Cooper, Marcel Demarteau, Cecilia Gerber, Eric Kajfasz, Mikhail Kubantsev, Frank Lehner, Petros Rapidis, Maria Roco, and Peter van Gemmeren, who are leading various efforts within this project, were both enlightening and informative. (We regret that we did not speak with others contributing to the project, particularly Alice Bean and Aurelio Juste.) The interviews occurred over a two week time span, and represented at least 24 hours of conversations. The discussions were informal, and in most cases the committee talked with one individual at a time.

After the interviews were complete, the committee met with Ron and Bill for approximately two hours to discuss its findings with them. The committee then met for approximately four hours with Montgomery, Tuts, and Weerts (Ron and Bill were unable to attend) to discuss the issues, and possible solutions to some of the problems. Both discussions, which took place on Friday, October 8, 1999, were quite frank, and the findings and recommendations reported during those discussions did not differ significantly from those contained in this written report. The report, however, does contain a few more details on some subjects than were discussed at either session, particularly in the section on recommendations for personnel additions.

The committee would like to express its genuine gratitude to the interviewees for their frank and thoughtful observations and insights. The findings, comments and recommendations compiled below result primarily from those discussions. We also note that the review itself took place approximately one month prior to this writing: some of the issues below may therefore have been addressed in the interim. We've tried to note this where possible, but due to the speed with which things are moving, these corrections may not always be complete.

2 Technical Issues

2.1 Findings

- The DØ SMT group has made substantial progress in the development of the team, techniques and tools necessary to successfully fabricate the silicon detectors for the DØ Upgrade. Production of both barrel and disk detectors is underway, and important progress in the planning and implementation of the 10% test is evident. The past year has seen significant growth in the project, and the initiation of the full production and testing effort. The entire silicon team is to be congratulated for getting this complex challenging project organized and underway.

- The ladder production facility is a well-managed production line. We have confidence in the ability of the silicon project to meet demands on this front, provided appropriate resources are made available to the people running it. This issue is addressed in more detail in following sections.

- Detector testing has been well organized, and an excellent job has been done to pull together viable means of addressing this complex and multi-faceted process. As of the time of this review, due to a lack of manpower (and in no way attributable to the manner in which the testing is run), the testing of completed detectors was lagging significantly behind production. This situation has been alleviated at some level by the recent addition of shifters into the effort.

- A non-negligible fraction of the tested detectors exhibit problems that might render them undesirable for use in the final detector assembly. In many cases, pulling wire bonds in order to fix noisy channels has not alleviated the noise problems.

- A number of other outstanding technical issues were raised during our conversations, including the biasing scheme for the 6-chip ladders, whether detectors are being tested to sufficiently high voltage, the impact of microdischarges on the eventual performance, the ability of 9-chip HDIs to be read out, and the viability of the low mass cable solution.

- Concerns were raised regarding the availability of CMM machines, and the potential consequences of downtime of key fabrication and testing machines. The maintenance of the Zeiss CMMs may be a problem. At the time of this review, the CMM for F disk production had been awaiting service for an extended period of time.

2.2 Comments

- While the sensor delivery is not currently the leading cause for concern, continued vigilance is appropriate to insure that detectors are delivered on schedule. Some individuals also expressed concerns regarding the delivery of other components such as HDIs and low mass cables. To keep this complex project on schedule will require careful attention to the performance of the

vendors involved. Inventory monitoring and control will likely be a significant aspect in the successful completion of this project.

- We note that there appears to be a large variation in the quality of the clean rooms employed for the various detector assembly stages, and hope that careful thought has been given to insure that needs are being met.

2.3 Recommendations

1. The silicon group must identify the causes of detector problems and establish techniques to address those issues as soon as possible. To aid in this crucial task, the team devoted to testing of the detectors and investigation of other technical issues should be supplemented with additional silicon expertise. The magnitude and demands of these technical aspects of the enterprise can be expected to grow as the production rate increases, and the issues uncovered must be addressed in a timely manner. Our recommendations regarding this additional expertise are discussed in some detail in Sec. 3 below.

2. Progress on the 10% test should continue to be pursued as expeditiously as possible so as to uncover and resolve any outstanding system issues as soon as possible. The types of problems encountered while building the detector will evolve with the project – from ladder testing to 12-ladder tests to the 10% test and beyond. Obtaining a head start on commissioning a large portion of the final working system is highly desirable.

3. The availability and especially repair of the production machines is an issue probably intimately related to the overall organization of SiDet, which we address separately in Sec. 4.

3 Personnel and Organizational Issues

3.1 Findings

- The DØ SMT group has tackled an extremely large and challenging task. Key responsibilities have been placed in the hands of very capable young physicists, but due to the scope and complexity of the project, additional personnel will likely be needed to complete the detector in a timely manner.

- The committee is impressed with the group of post-docs working on the detector, but as suggested by a number of those post-docs, the committee feels that the project would benefit from additional regular interactions with experienced silicon experts. Frequent and detailed consultations with such experts should help address the remaining challenges that production and testing will inevitably uncover.

- There is significant discontent among the DØ physicists working at SiDet. Many feel that there is little recognition of their efforts, minimal visibility for those working in the trenches, and most expressed concommitant fears about the potential negative impact that working there might have on their futures. The younger physicists believe that they would benefit from closer communication with the top level. They expressed feelings of disenfranchisement. They wish to be embraced as part of the larger effort, kept informed on the overall project and its progress, and its impact on the DØ and Laboratory schedule. There was a perception in many cases that the milestones, and in some cases the schedule itself, was established by the silicon project managers without sufficient consultation with the principals. Displeasure was also registered regarding the reassignment of resources prior to discussing these personnel reassignments with those in charge of the sub-systems. A number of decisions appear to be made with little or no discussion with the group(s) that are most directly impacted.
- There is no readily available and widely distributed organizational chart for the silicon effort.
- The technician effort appears to be well organized. The technicians that we spoke with seemed to have a clear concept of who to contact when they had questions, and their priorities were clearly set.
- Bill Reay will likely return to his teaching responsibilities in Kansas in January, which will require that he commute regularly in order to remain abreast of developments.
- During all production to date, a physicist has been monitoring the work of a wirebonder during the entire wirebonding process. The committee, and some of the interviewees, questioned whether monitoring at this level was necessary and/or appropriate throughout the full production phase.

3.2 Comments

- The recent addition of the Brown group to the team involved in mechanical and installation issues represents another positive step in addressing the needs of this important portion of the project. We hope that the integration of this team is being accompanied by proper consultation with the principals already involved.
- A clear delineation of people's responsibilities may ease the entry of additional personnel into the project.
- The H disk project appears to have one of the larger and more experienced teams within the DØ silicon project.
- There is concern that the Fresno State group might be overburdened by the HDI oversight and testing that they are responsible for, especially as the demand for production quantities grows at SiDet.

- In order to meet the schedule, the committee believes that another shift will need to be in place in the very near future. This will require significant planning to be effectively implemented, and those plans will need to be developed as soon as possible.

3.3 Recommendations

1. As already mentioned, the committee believes that more experienced silicon expertise needs to be made available for the building, testing, repairs, read out, assembly, and installation of the detector. The debugging of fabricated detectors is a particular concern, as production continues without a complete understanding of the problems with the detectors that have already been made. Since Ron Lipton is one of the most technically knowledgeable silicon experts on DØ, he should be freed up as fully as possible from his administrative responsibilities in order to focus on silicon detector production, testing, debugging, and repair, as well as later sub-detector (*i.e.*, barrel) assembly and testing. In order to free up Ron's time, we recommend that the other silicon co-leader assume most of the administrative responsibilities, such as hiring, resource allocation, scheduling, WBS efforts, expediting, and personnel and organization, so that Ron can concentrate his efforts as fully as possible on technical issues.

   The committee believes that at least two silicon sub-project managers are needed, and that both of them should be based at Fermilab, able to devote their full time to the project, and that they should come from within DØ. We believe that the return of Bill Reay to Kansas in January demands that another sub-project manager be identified as soon as possible. We take this opportunity to note that Bill has clearly had a positive impact on many aspects of the project and has much to offer, and that the project would benefit from his continued active involvement to the degree that his schedule permits.

2. DØ silicon management should find appropriate means to communicate the essence of significant developments to all involved in the project. Open discussion of testing results and the possible approaches to dealing with detectors exhibiting problems should be more actively pursued and encouraged. Clear communication of schedule issues and open discussions of plans for addressing recovery from any slippages must occur. The updated schedule should be readily available and posted. One visible way of potentially improving communications within the project would be for silicon management to establish their offices at SiDet. The committee strongly encourages DØ management to try to find a way to establish office space at SiDet for most or all of the personnel working on the silicon detector.

   We also urge DØ silicon management to be more attentive in providing mentoring and guidance to the post-docs in order to reduce their frustrations in this challenging undertaking.

3. A clear, comprehensive organizational chart, delineating as clearly as possible levels of authority and responsibility, should be made available as soon as possible.

4. The committee feels that the services of an expediter might relieve silicon management from some of the administrative burdens. We also believe that a mechanism for keeping track of the many vendor-supplied components should be developed and maintained – for example, a frequently updated spread-sheet of some kind. The maintenance of such an accounting system could (and should) be the responsibility of such an expeditor or a secretary at DØ.

5. The committee recommends the following personnel additions:

    a. Shift workers for production and testing could be put to good advantage. The committee feels that these people would best come from the pool of our DØ collaborators. Those offering (or commandeered) to help must be made aware that they will be expected to be conscientious over the long term in order to make the effort to train them worthwhile.

    b. The engineering physicist position intended to provide relief for the production manager should be filled as soon as possible.

    c. Another full-time student or post-doctoral physicist should be made available to help on the 10% test.

    d. The team responsible for detector testing and repair should be assigned additional appropriate assistance as soon as possible. We recommend that Lynn Bagby devote 50% of her time to the task, and that a technician be identified to work under her for hands-on repairs of the devices. Wayne Schmitt may be a viable suggestion for the latter work, although we feel that he should be relieved of his safety and other duties at DAB if he is asked to take on this extra responsibility. The committee believes that testing and repair is a critical aspect of the project and that it would benefit from the full-time participation of an additional engineering physicist. Additional technician labor for the actual repair of ladders should also be provided with as little delay as possible, as it is needed.

    e. Given the magnitude of the testing effort, we believe that a deputy should also be found to help Cecilia run this operation.

    f. Some means of support should be found for E. Zverev, who is responsible for maintaining hardware for testing readout, so that he can stay here through the completion of the project. If this is not possible, then someone else must be identified to take on these responsibilities.

    g. If L. Rytchenkova is working only temporarily on the F disks, an additional technician will be needed in this sub-group.

    h. A strong effort should be made to find the resources to get E. Shabalina and her student(s) to Fermilab so that that team can contribute to ladder testing, the 10% test, and the software necessary for commissioning of the silicon detector. Our understanding is that living expenses are the only impediment here.

i. DØ management should attempt to identify and recruit additional silicon experts who might contribute (at least part-time) by being available to consult on problems. Perhaps J. Ellison or B. Gobbi, or non-DØ Fermilab personnel experienced in silicon, could be made available for such assistance.

6. A detailed plan for the implementation of a second production shift (or split shift) should be advanced as soon as possible.

4 SiDet Facility and Related Issues

4.1 Findings

- In principle, the management philosophy at SiDet seems to be to pool resources. In practice, some technicians are apparently assigned to DØ, and some wirebonders have also been assigned to DØ. However, SiDet management announced a reorganization while this review was in progress, and the future disposition of resources is not clear. At this time, one of three wirebonding machines is assigned to DØ, a second is assigned to CDF, and the third is assigned to the ISL (a CDF project) as well as other projects.
- The splitting of the time of individuals in the engineering pool between DØ and CDF was cited as inhibiting proper steady progress.
- Maintenance of the wirebonding machines has been a concern.
- Allocation and scheduling of the 8090 wirebonding machine is likely to become a contentious issue as production heats up.

4.2 Comments

- After the recent upper-level reorganization at SiDet, all members of the top management tier – the leader and all three deputies – have direct connections to CDF. DØ is no longer directly represented in the SiDet chain of command. The reward structure for the SiDet technicians is thus heavily influenced by personnel who have more interest in CDF than in DØ. This imbalance is a cause for concern. Both detector groups are planning to be in full production by December, 1999; when the limited resources become saturated, as we expect they will, any inequities in the allocation of those resources will need to be addressed by the DØ Upgrade project management. Monitoring of these resources might become necessary.
- The DØ management and the silicon project leadership should also maintain an awareness of the future utilization of SiDet resources (for example CMS activities) and its potential impact on production of eventual replacements for at least parts of the SMT.

- There was some interest expressed in improved availability of mechanical and electrical technicians whose efforts could be called upon to reduce the downtime for production machines at SiDet.
- The availability of data entry and shipping/receiving support personnel would relieve some of the younger physicists from performing these tasks.

4.3 Recommendations

1. While we understand and appreciate that pooled resources allow for at least the appearance of optimum utilization of resources, and allow shifting of resources to balance loads and accommodate vacations and sicknesses, we believe that when feasible wirebonders should effectively be assigned to the different projects so that they become more familiar with the detectors and the requirements of the experiments. Such nominally fixed assignments will enhance efficiency and communication through familiarity while reducing the demands on the individual wirebonders. The DØ silicon management, in conjunction with DØ Upgrade project management, should carefully monitor availability of such pooled resources to insure that our interests are served.
2. It is very unfortunate that DØ no longer has direct representation in the upper management of the SiDet facility. DØ management should carefully consider the current situation and monitor the allocation of resources appropriately.

5 Summary

The silicon detector is at the heart of the DØ Upgrade and must be completed in a timely fashion in order for DØ to achieve its physics goals. An energetic team has been working intensely to achieve those goals and substantial progress has been made, but that team will need additional support. Significant changes will likely be required for the detector to be delivered on schedule. Emphasis on testing and repair must be enhanced as the production is stepped up to meet goals. Numerous significant technical challenges remain to be conquered, and the effort of the leadership should be redistributed to focus the resources optimally. Efforts must be made to improve communication between the upper level of silicon management and the rest of the project to enhance productivity and improve morale.